PRISM ENGINEERING

December 13, 2005

Dan Landon, Executive Director
Nevada County Transportation Commission
101 Providence Mine Road, Suite 102
Nevada City, CA 95959

RE: TRAFFIC OPERATIONS STUDY FOR CALTRANS AT THE SR 20/49 EB RAMPS AND IDAHO MARYLAND INTERSECTION

Dear Dan:

This letter report summarizes the traffic operations study conducted on Idaho Maryland Road at the intersections of SR 20/49 EB Ramps and Railroad Avenue. The purpose of this study was to collect new traffic data and determine the levels of service for a variety of existing and future scenarios, as defined in this report.

Turning Movement Data Collection

PRISM Engineering conducted two-hour vehicle turning movement counts during the am and pm peak hours turn on Tuesday and Wednesday, October 13 and 14 at Idaho Maryland Road and SR 20/49 ramps, and at Idaho Maryland Road and Railroad Avenue. Figure 1 details these peak hour turning movements.

Signal Warrant Analysis

The MUTCD[1] Peak Hour Volume Warrant (Figure 4C-3 in MUTCD) was used in this study to determine when the study intersection of Idaho Maryland at SR 20/49 eastbound off ramp warrants a traffic signal. The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street. This condition happens for more than one hour each day. Figure 1 shows the peak hour traffic volumes that were used in the signal warrant analyses. Both the am and pm peak hour volumes were considered. Figure 2 shows

[1] Manual On Uniform Traffic Control Devices

the signal warrant graphs that correspond to the volume of traffic on the approach lanes entering an intersection for the peak hour and four hour criteria, respectively. Table 1 shows the specific "Peak Hour Warrant" results for the year 2005 through year 2011. The peak hour volume signal warrant is met for both the am and pm peak hour time periods in the existing year 2005. The warrant is appropriate for use in this area because of the LOS F conditions on the side street approaches of the SR 20/49 EB offramp. During the am peak hour, the major street associated in Figure 2 is the SR 20/49 EB off ramp, while in the pm peak hour, the major street in this analysis is Idaho Maryland.

The MUTCD 4C Warrant #2, "Four Hour Vehicular Volume," is also met for the Year 2005 traffic volumes. The fourth highest hour occurs in the am time period, from 6:30 am to 7:30 am. The major street in this case is the SR 20/49 offramp, which has an approach volume of 636 vehicles per hour during this time period. The "side street" of Idaho Maryland has an hourly volume of 383 for the same time. Using the second line in the chart shown in Figure 2, it can be seen that the signal warrants are met for this volume if the side street volume exceeds 280 vehicles per hour (using 636 as the value along the horizontal axis). Since the side street volume is 383, the signal warrants are met using MUTCD Signal Warrant #2.

The pedestrian volume warrant was also considered. However, only a handful of pedestrians were observed during the peak hour time periods when traffic was counted. In order to meet MUTCD Warrant #4 for Pedestrian Volume, there needs to be over 190 pedestrians crossing the major street for any one hour. This is certainly not taking place, and Warrant #4 is not met.

Other warrants such as MUTCD Section 4C Warrant #5 School Crossing, Warrant #6 Coordinated Signal System, Warrant #7 Crash Experience, Warrant #8 Roadway Network, etc., were also considered, but deemed not applicable to this particular location. More information can be found for these and other warrants on the internet at:
http://mutcd.fhwa.dot.gov/HTM/millennium/12.28.01/four_highway_traffic_signals/MUTCD_4A-4D.htm#section4C03

Signal warrants were met for two different conditions, both the peak hour and four hour warrants, for the current Year 2005 condition.

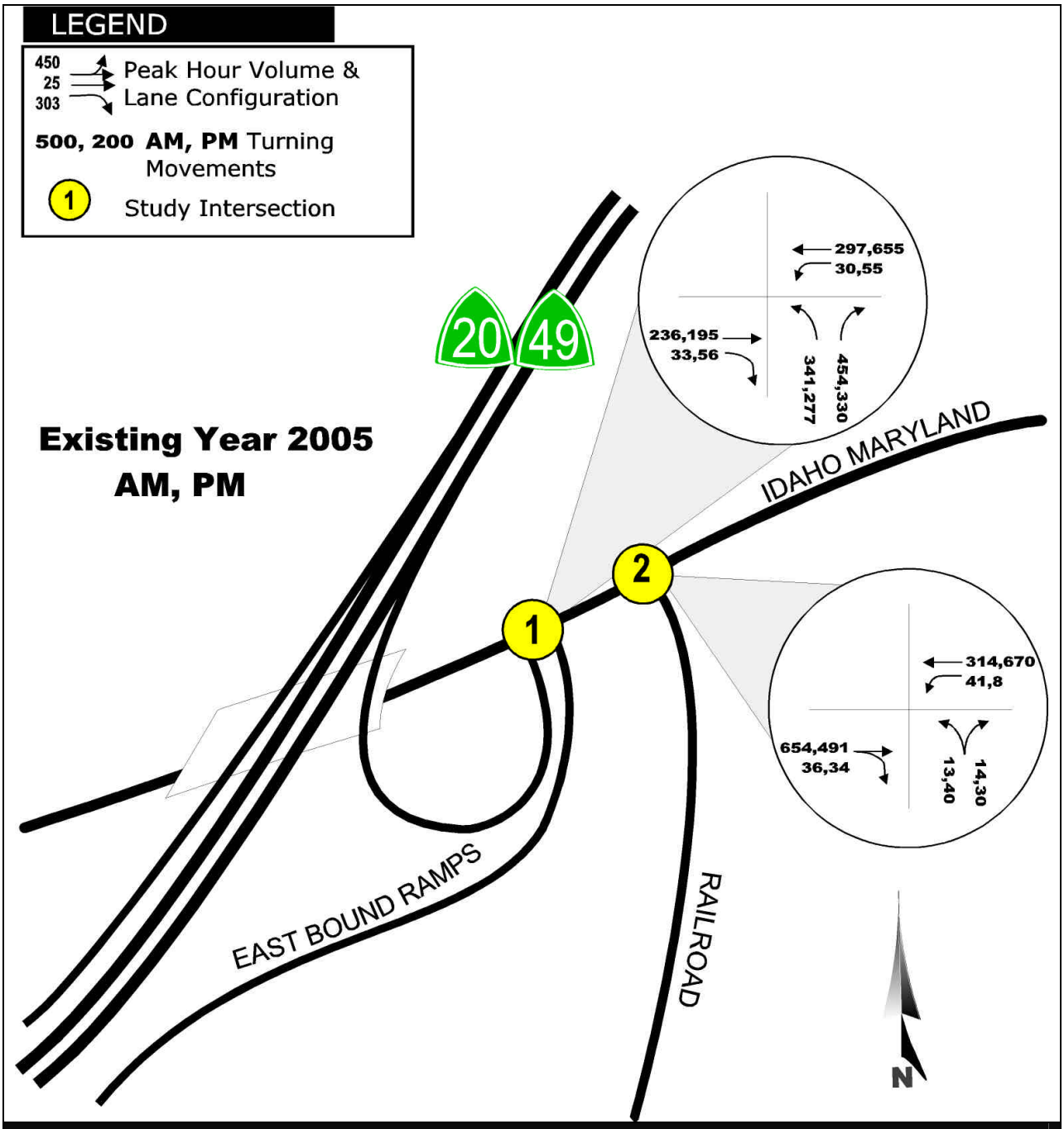
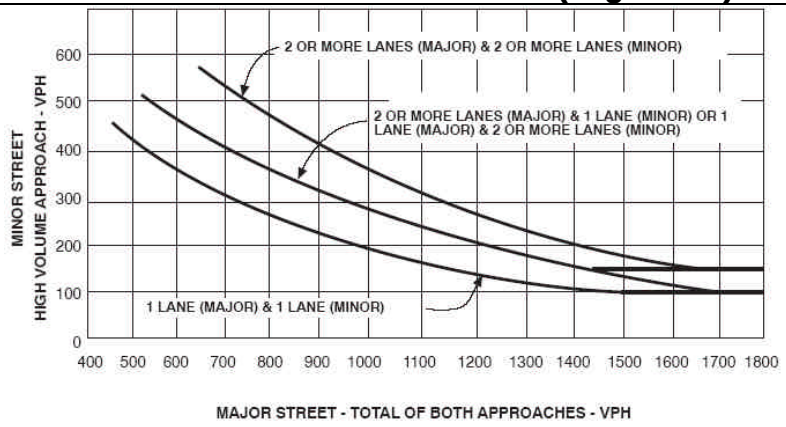


Figure 1 AM and PM Peak Hour Turning Movements

MUTCD Peak Hour Warrant (Fig 4C-3)



MUTCD Four Hour Warrant (Fig. 4C-1)

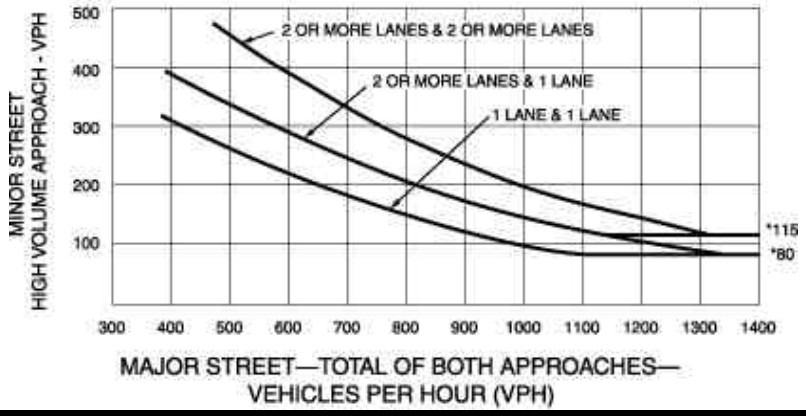


Figure 2 MUTCD Section 4C Signal Warrant Criteria

Table 1
Signal Warrant Analysis Summary
MUTCD Warrant #3, Peak Hour Warrant

PM peak hour				AM peak hour			
Year	Major St Idaho M.	Minor St SB ramps	Signal Warranted ?	Year	Major St SB ramps	Minor St Idaho M.	Signal Warranted?
2005	934	607	yes	2005	795	596	yes
2006	957	622	yes	2006	815	611	yes
2007	981	638	yes	2007	835	626	yes
2008	1006	654	yes	2008	856	642	yes
2009	1031	670	yes	2009	878	658	yes
2010	1057	687	yes	2010	899	674	yes
2011	1083	704	yes	2011	922	691	yes
growth rt 2.5 % per year							

Source: PRISM Engineering and MUTCD Section 4C

Year 2011 Traffic Projections

Caltrans AADT (Annual Average Daily Traffic)[2] volumes were utilized to determine a 2.5% per year growth rate for the study intersections[3]. Table 2 shows the growth from Year 1992 to 2002 volumes.

Table 2
AADT Growth Factor for SR 20/49 at Idaho Maryland

	1992	2002	Growth Rate
Annual Average Daily Traffic	36,000	44,000	2.5%/yr

Source: PRISM Engineering, Caltrans AADT

Table 3
PM Peak Hour Turning Movements
for Approved Projects and Proposed Projects

Project Name	Project Generated Peak Hr. Trips	Idaho Maryland at SR 20/49 EB ramp					
		EB		WB		NB	
		THRU	RT	THRU	LT	LT	RT
Approved Projects							
SNMH		21		8		27	
Weaver Auto		29		19	10		13
Litton Retail Center	3					3	
Moule Paint & Glass	9	4	3	1		1	
Morgan Ranch West	4					4	
Fun Hill	7	1		4	1		1
Total Approved	**23**	**55**	**3**	**32**	**11**	**35**	**14**
Proposed Projects							
Hills Flat Lumber	86	17		28	10		13
Ridge Village	7	1		1		5	
Chapa De	4	2		1		1	
Berg Heights	14	4		6		4	
Total Proposed	**111**	**24**	**0**	**36**	**10**	**10**	**13**
Grand Total	**134**	**79**	**3**	**68**	**21**	**45**	**27**

Source: City of Grass Valley, PRISM Engineering

The 2.5%/year growth rate was applied to the year 2005 existing turning movements to get to year 2011 conditions turning movements at the study intersections (shown in Figure 3). Two additional scenarios were included in this study that include all approved projects in the City of Grass Valley, as well as proposed projects in and around Grass Valley. Table 3 documents the turning movements of each these projects. Figures 4 and 5 show the turning movements for these future scenarios.

[2] Obtained from Caltrans website: http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/2004all.htm
[3] Calculated by taking 2002 Caltrans annual average daily traffic divided by 1992 AADT counts on SR 20/49 in the vicinity of the Idaho Maryland Ramps: 44,000/36,000=1.25, or 2.5%/year for 10 years.

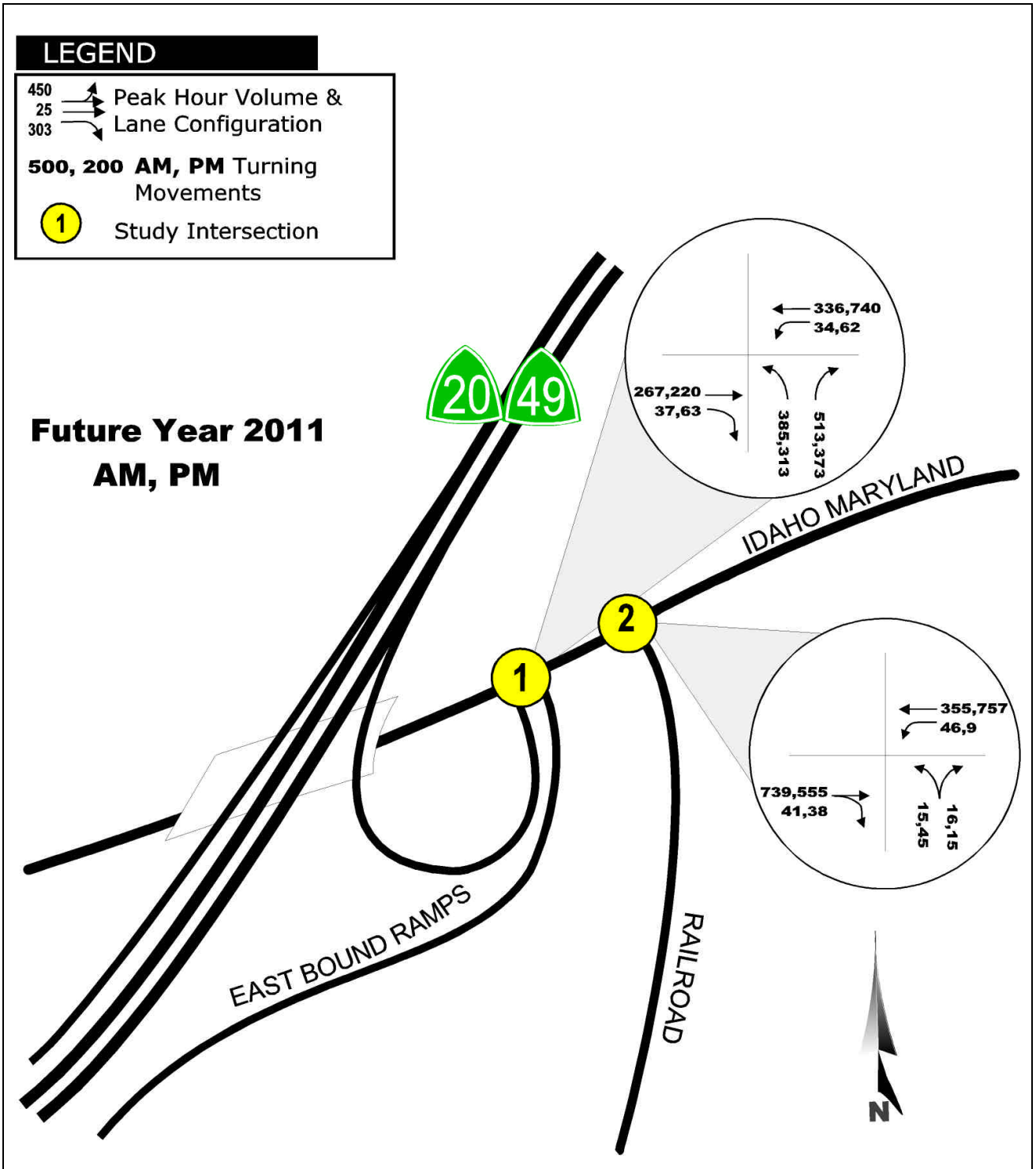


Figure 3 Year 2011 AM and PM Peak Hour Traffic Projections

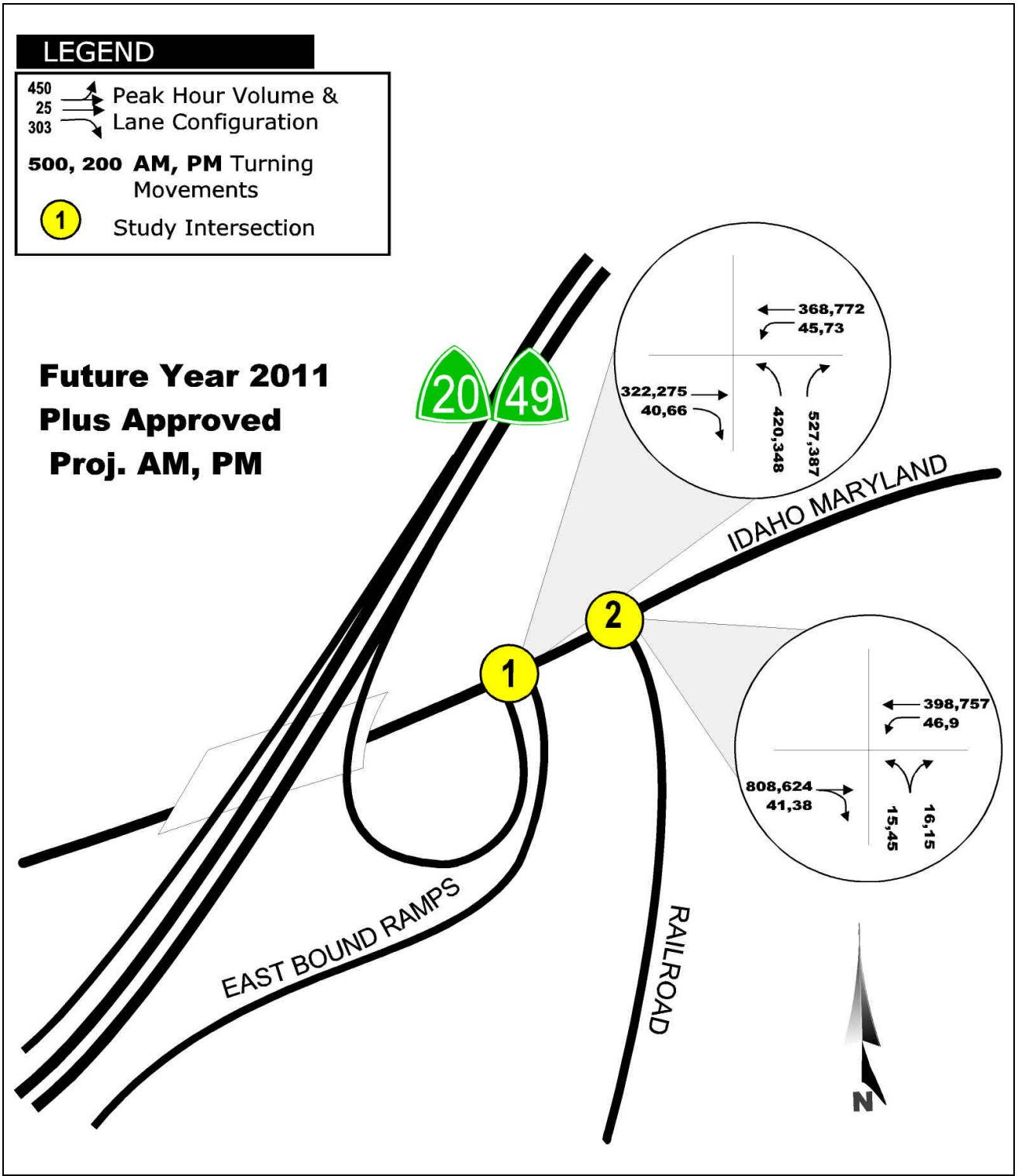


Figure 4 Year 2011 Plus Approved Projects

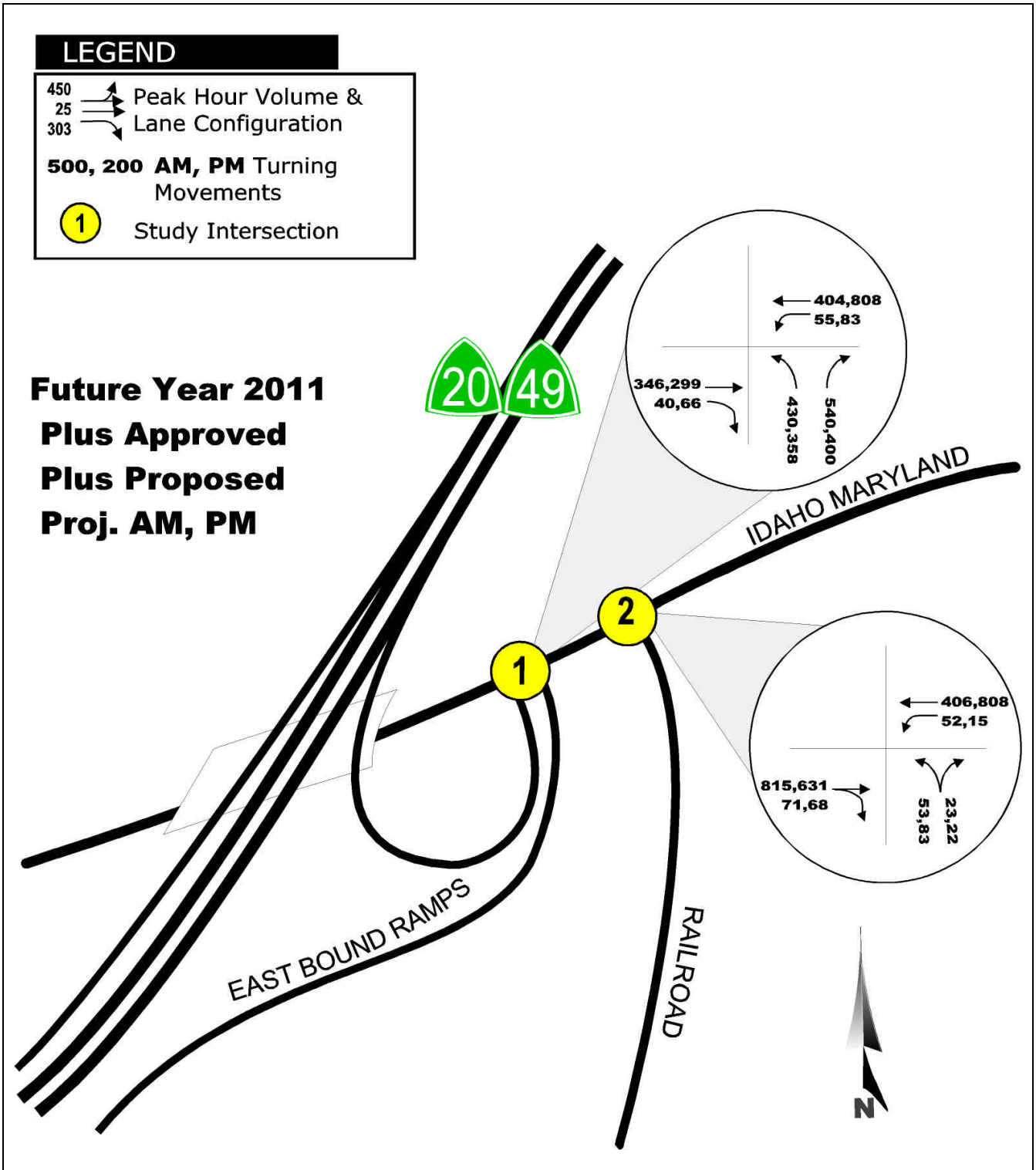


Figure 5 Year 2011 Plus Approved Plus Proposed Projects

Capacity and Level of Service Analyses

Methodology

The HCM 2000 methodology was used for all intersection capacity analyses in this report. Micro-simulation of the traffic was also used to aid in determining whether left turn pocket lengths would be sufficient for satisfactory traffic operations between the two closely spaced intersections of SR 20/49 EB Ramps and Railroad Avenue on Idaho Maryland Road. The SimTraffic micro-simulation traffic model was utilized to observe existing and projected traffic volumes. Left turn pocket lengths at the study intersection were analyzed using micro-simulation and queue length analyses.

A capacity analysis was performed for eight (8) different scenarios including:

- Existing Year 2005 AM Peak Hour
- Existing Year 2005 PM Peak Hour
- Existing Year 2011 AM Peak Hour
- Existing Year 2011 PM Peak Hour
- Existing Year 2011 plus Approved Projects AM Peak Hour
- Existing Year 2011 plus Approved Projects PM Peak Hour
- Existing Year 2011 plus Approved and Proposed Projects AM Peak Hour
- Existing Year 2011 plus Approved and Proposed Projects PM Peak Hour

The detailed capacity calculations are contained in the appendix of this report. The intersection levels of service are measured in terms of delay as per the Year 2000 Highway Capacity Manual (HCM).

Table 4 shows the 2000 HCM criteria for delay and corresponding level of service (LOS). According to the standard methodology, a signalized intersection is at LOS F when the average delay to a motorist exceeds 80 seconds. An unsignalized intersection is at LOS F when motorists have an average delay of more than 50 seconds.

All traffic volumes for each of the scenarios listed above were entered into the SynchroPro software and analyzed using the HCM 2000 methodology procedures, and the results are reported in Tables 5, 6, and 7 of this report. In addition to the HCM 2000 reporting procedures, we employed micro-simulation analysis methodology to visually check turning movement operations in the area, queue lengths, especially at left turn pockets. In all of our observations for signalized operations, the traffic on the SR 20/49 EB Ramps and Idaho Maryland Road operated satisfactorily as LOS B conditions. However, if Railroad Avenue is not signalized too, LOS F conditions will exist for traffic trying to get out onto Idaho Maryland Road.

Table 4
Delay Level of Service Criteria

LOS	Unsignalized	Signalized
A	1-10 seconds	1-10 seconds
B	11-15 seconds	11-20 seconds
C	16-25 seconds	21-35 seconds
D	26-35 seconds	36-55 seconds
E	36-50 seconds	56-80 seconds
F	51+ seconds	81+ seconds

Source: PRISM Engineering, Synchro Pro, and HCM

Table 5 reports the capacity analysis summaries for the am and pm peak hour Year 2005 and 2011 scenarios, using only the existing lane configurations and stop sign control.

Table 6 reports the capacity analysis summaries for the am and pm peak hour Year 2005 and 2011 scenarios, with a signal installed at the SR 20/49 EB Ramp intersection with Idaho Maryland Road. Railroad Avenue was left as a stop sign controlled side street for this set of assumptions. Conservative protected left turn phasing was assumed for signal control at the intersection. Traffic operations would be at LOS B conditions for the newly signalized intersection, but side street delays on Railroad Avenue would be at LOS F conditions when the approved and proposed projects traffic is considered.

Table 7 reports the capacity analysis summaries for the am and pm peak hour Year 2005 and 2011 scenarios, with a signal installed at both the SR 20/49 EB Ramp intersection with Idaho Maryland Road, as well as at Railroad Avenue and Idaho Maryland Road. The two signals were coordinated using microsimulation, and given an appropriate offset to coordinate their timing. Traffic operations would be at LOS B conditions with this alternative, even with the approved and proposed projects.

Table 5

Capacity Analysis Summary

UNSIGNALIZED, Existing Lanes

Unsignalized			AM Peak Hour		PM Peak Hour	
2005 AM and PM peak hour Level of Service			**2005**		**2005**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	17.7	C	34.7	D
2	Idaho Maryland	Railroad	0.08	A	1.2	A
2011 AM and PM peak hour Level of Service			**2011**		**2011**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	34.7	D	70.1	F
2	Idaho Maryland	Railroad	1	A	1.7	A
2011 + Approved Projects AM and PM peak hour Level of Service			**2011 + Approved Projects**		**2011 + Approved Projects**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	68.8	F	117.5	F
2	Idaho Maryland	Railroad	1	A	2	A
2011 + Approved + Proposed Projects AM and PM peak hour Level of Service			**2011 + Approved + Proposed Proj.**		**2011 + Approved + Proposed Proj.**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	93.7	F	147.9	F
2	Idaho Maryland	Railroad	3.1	A	7.5	A

Note: Side Street Delay is delay occuring at the EB ramps and at Railroad Ave.

Source: PRISM Engineering

Table 6

Capacity Analysis Summary

After Mitigation[4]

Signal at SR 20 EB ramps only			AM Peak Hour		PM Peak Hour	
2005 AM and PM peak hour Level of Service			**2005**		**2005**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	10.1	B	11.6	B
2	Idaho Maryland	Railroad	0.9	A	1.4	A
2011 AM and PM peak hour Level of Service			**2011**		**2011**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	11.2	B	13.8	B
2	Idaho Maryland	Railroad	1.1	A	2.1	A
2011 + Approved Projects AM and PM peak hour Level of Service			**2011 + Approved**		**2011 + Approved**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	14.3	B	16	C
2	Idaho Maryland	Railroad	1.2	A	2.8	A
2011 + Approved + Proposed Projects AM and PM peak hour Level of Service			**2011 + Approved +**		**2011 + Approved +**	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	15.4	B	16.6	B
2	Idaho Maryland	Railroad	5.8	A	13.8	B

Note: Side Street Delay is delay occuring at the EB ramps and at Railroad Ave.

Source: PRISM Engineering

[4] Signal Installation at SR 20/49 EB Ramps ONLY

Table 7

Capacity Analysis Summary

After Mitigation[5]

Signalized (dual signals)			AM Peak Hour		PM Peak Hour	
2005 AM and PM peak hour Level of Service			2005		2005	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	11.5	B	10.9	B
2	Idaho Maryland	Railroad	5.4	A	10.1	B
2011 AM and PM peak hour Level of Service			2011		2011	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	14.9	B	12.9	B
2	Idaho Maryland	Railroad	9	A	10.1	B
2011 + Approved Projects AM and PM peak hour Level of Service			2011 + Approved Projects		2011 + Approved Projects	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	17.3	C	16	C
2	Idaho Maryland	Railroad	9.2	A	10.1	B
2011 + Approved + Proposed Projects AM and PM peak hour Level of Service			2011 + Approved + Proposed Proj.		2011 + Approved + Proposed Proj.	
			HCM Average Delay	HCM LOS	HCM Average Delay	HCM LOS
1	Idaho Maryland	EB ramps	20.3	C	18.1	B
2	Idaho Maryland	Railroad	10.9	B	10.7	B

Note: Side Street Delay is delay occuring at the EB ramps and at Railroad Ave.

Source: PRISM Engineering

[5] Signal Installation at SR 20/49 EB Ramps AND Railroad Avenue (Coordinated System)

Queue Length Analyses

The queue analyses inspections of microsimulation showed no problems with excessive queue lengths for any approaches of the study intersections. Traffic operations observed in micro-simulation appeared to be consistently working at LOS B or better conditions for all lanes.

Conclusion

The currently unsignalized intersections of Idaho Maryland Road at SR 20/49 EB Ramps and Idaho Maryland Road at Railroad Avenue are operating at an "overall" average of LOS C and D conditions, respectively. However, during the PM peak hour, the "side street" SR 20/49 off ramp experiences LOS "F" conditions. This is because it is the only stop sign controlled approach at the intersection, and the heavy westbound through movement on Idaho Maryland Road which does not provide enough gaps in traffic for the offramp traffic to efficiently enter Idaho Maryland Road. A similar situation exists at the Railroad Avenue side street approach. In the am peak hour, the offramp traffic is slightly greater in volume than the pm peak hour offramp traffic, but because the Idaho Maryland traffic is significantly less, the level of service for the offramp is only LOS D.

Signal warrants are met now for the intersection of Idaho Maryland at EB SR 20/49 based on the MUTCD[6] Warrants #2 Four Hour Volume, and Warrant #3 Peak Hour Volume (See Figures 4C-2 and 4C-3 in MUTCD) for the existing am and pm peak hour traffic counts.

The year 2011 projections will experience LOS "F" conditions in all scenarios without mitigation, and the signals warrants are still met for this condition.

Single Signal Installed At Idaho Maryland / SR 20/49 EB Ramps

If a signal is installed at the SR 20/49 EB Ramps intersection with Idaho Maryland Road, LOS B conditions will exist at the intersection. However, Railroad Avenue will still experience LOS F conditions on the side street approach, and more especially with approved plus proposed projects.

Dual Signals Installed At SR 20/49 EB Ramps and Railroad Avenue

With a coordinated signal system installed at both the SR 20/49 EB Ramp and Idaho Maryland Road intersection, as well as at Railroad Avenue and

[6] Manual On Uniform Traffic Control Devices

Idaho Maryland Road intersection, LOS B conditions are projected. The two signals must be coordinated together with an appropriate offset to coordinate their timing. Details of the LOS B condition are given in the appendix.

If you have any questions, or if further information is needed, please do not hesitate to call.

Sincerely,
PRISM Engineering

Grant P. Johnson, PE, PTOE
Principal

Appendix

Turning Movement Counts / Peak Hour Analysis
Queue Analysis Summaries
HCM Reports
HCM Reports for MITIGATED Scenario: Dual Signal
HCM Reports for MITIGATED Scenario: Single Signal at EB ramps